Alternative fresh water sources for remote settlements

Yusup Kamalov yusup-udasa@mail.ru
Karakalpakstan Branch of the Uzbekistan Academy of Sciences
41 propekt Berdakh, Nukus, Karakalpakstan, Uzbekistan 230100

Introduction

Water sources in remote districts of Karakalpakstan (an autonomous part of Uzbekistan, located around the former Aral Sea) are mostly wells and boreholes. The water is brackish, to 2.3 grams per liter, but the most ground waters are up to 14 g/liter. Rainfall does not exceed 100 mm a year. The climate is sharply continental. Summer temperatures reach 50 degrees Celsius, winter – up to -40. Today, on the day of this writing, the 30th January 2014 the temperature outside is minus 25 degrees. In villages which are close to cities the imported water can be used, but its transportation is very expensive. In larger towns the desalination plants using different methods of distillation or reverse osmosis were has built. However, it is expensive also, and requires a lot of energy and imported parts and supplies. Limited quantity and low water quality and lack of energy does not allow to raise the standard of living, and to achieve acceptable sanitary conditions for the population in isolated communities. Use of heavily mineralized water leads to increase of diseases associated with formation of stones in the kidneys and in other organs.

All this leads to the rural population's exodus to the cities, and, therefore to fewer opportunities to diversify the economy of the republic. Most often, people living in remote regions of Karakalpakstan are deal transhumant that allows using the resources of arid and semiarid lands. At the same time, at the presence of acceptable quality water they would grow fruits and vegetables for themselves, not to spend money on their purchase and transportation from distant oases.

Research Objectives

There is a need to find suitable methods of desalination and construct a simple and relatively cheap device that could be built in remote settlements. This device should be simple to maintain and does not require a lot of energy. It is desirable to use available renewable energy sources in the given area. The broken device should be easily repaired by the population itself.

Methods

The evaporative cooling method is known and used in almost all refrigerators, desalters, air conditioning systems and cooling towers. The latter ordinary water is used, that reduces the cost of the device but increases its size. In our case we have already surface of the roof of the house. The roof is made of galvanized steel and can be used both as an evaporation surface (outer surface), and as a condensation surface - the lower surface of the roof. Water from an underground reservoir of saline groundwater is served on the roof of the building (see Figure 1).

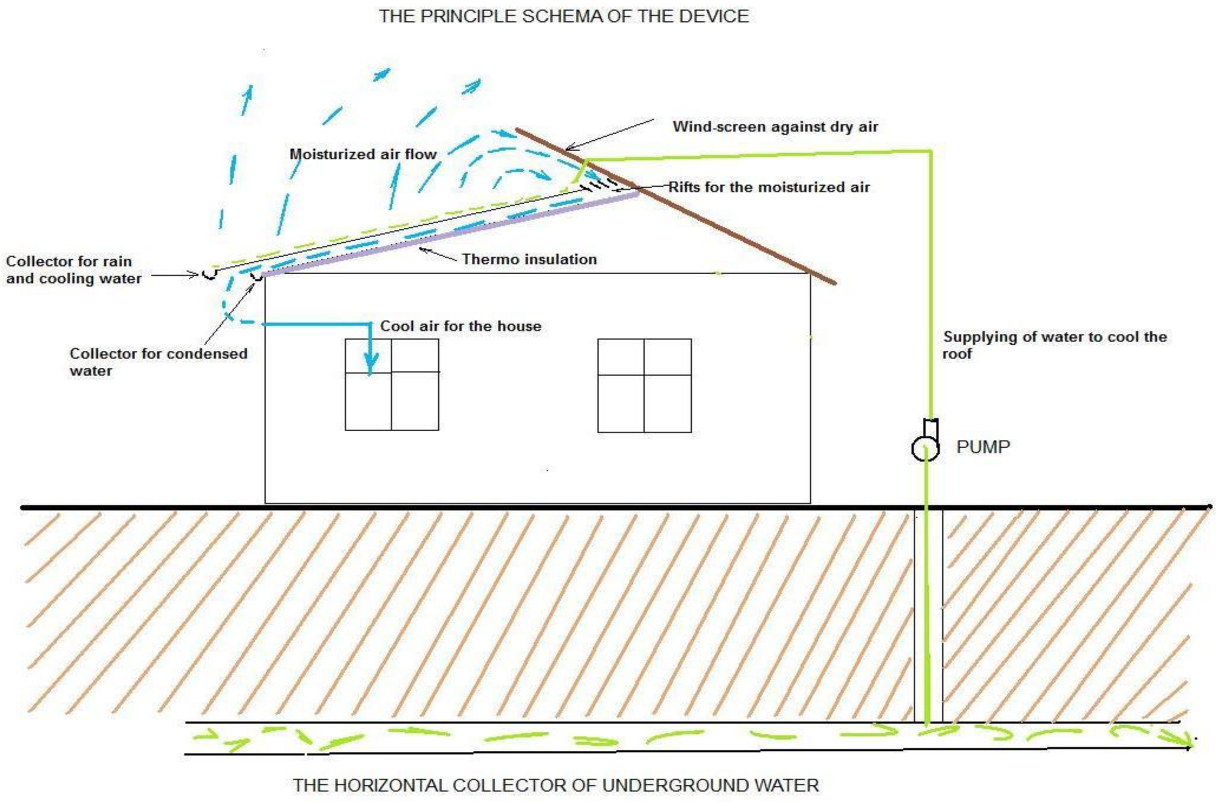

Figure 1.

The upper part of the metal roof is irrigated by underground salty water. Because of evaporation the metal is cooled. A part of moisturized air from above of the roof is going under the metal along rafters and coming down by parallel canals (See figures 2 and 3).

Figure 2: Lower end of the canals for the moisturized air.

Because the metal is cool some part of the moisture is condensed and drips on the plastic which shapes the canals for moisturized air. The cooled air became heavier, and it rolls down and pulls up the next portion of air from above the roof.

The productivity of the distiller depends on the surface of the cooled roof. If from 100 m² of the surface 24 cubic m of salt water will be evaporated every day (10 liters/hour/1 m²), then the only 1/10th of those moisture will come into the cooling canals (2.4 cubic m or 1liter/hour/1m²). Finally only 1/10th of it will be condensed, so we will get totally 240 liters of fresh water a day. In my case 60 m² of roof are available. That means we have to obtain about 140 liters of fresh water a day which is more than enough for 4 family or 20 people.

This device is not functioning in cold season. That is why we were looking for another reliable alternative method of fresh water supply in winter time. During freezing time it is possible to desalinate water by freezing but such low temperature does not happen sometime. At the same time all houses have fireplace or heaters to warm up homes. In the remote settlements people always use wood or other plants for it. Taking in consideration that the main outcome of the burning is water we decided to condense vapor from the exhausted gases. Here it has to be mentioned that the fresh

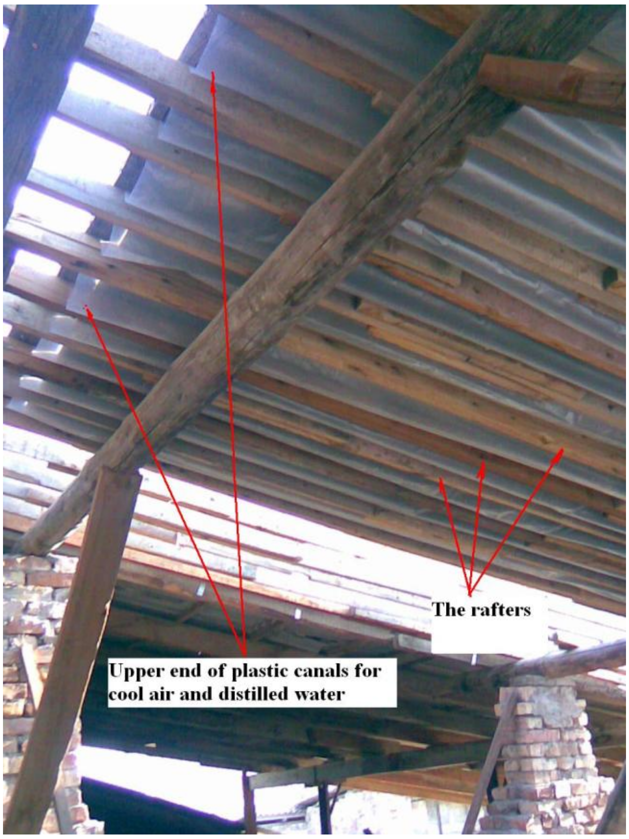

Figure 3: Upper end of the canals for moisturized air

water is needed not only for drinking or irrigation but also for constructing. Finally we found a design of the device, See figure 4.

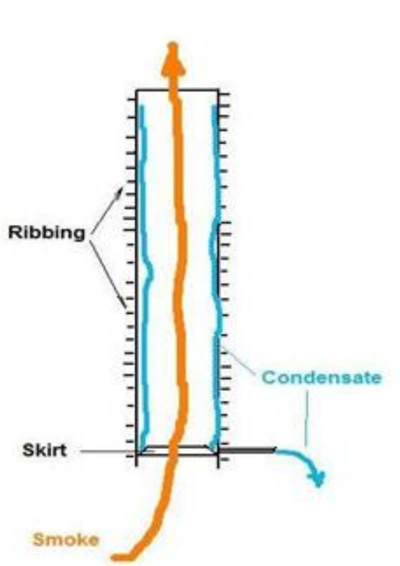

Figure 4: principle schema of the smoke tube to condense vapor.

Results

Smoke tube

The smoke tube condenser was made first and has functioned during five years giving about 10 liters of condensate a day. After simple filtration and staying for several hours it was mixed with tap water and used for drinking.

The samples of the condensate were given to three different governmental laboratories dealing with water quality. No one could find any kind of danger substances in there.

Unfortunately the metal has been eaten by corrosion from inside because of mistake during exploitation. Once the condensate in the pipe became frozen and the water was not able go outside of the tube. See the photo. Now we are looking for a plastic which should be available in the local market and may protect the metal against contact with the water. Nevertheless this device has demonstrated reliable results and could be recommended for the places with lack of water and with low quality of water.

The condenser on the roof

The condenser on the roof was tested twice using the tap water instead of salty water because the collector of salty underground water was not prepared yet. The distilled water contents no any salt, and the only very little concentration of zinc were found which is much less then in tap water.

After the tests the plastic film which was serving as canals for air and distilled water was ragged and we were not able to continue the experiments. This plastic was taken in the local market. Now we are in the process of making those canals using ordinary plastic tubes which are also available in the local market and have more high properties against high temperature in the summer and low temperature in the winter. These tubes are made from plastic waste and therefore they are cheaper than usual ones.

The next step is making of those canals and rafters as one unit from the same plastic waste. It should be mentioned here that the wood for ordinary rafters is imported from abroad and therefore very expensive. The local trees are available but very often attacked by termites and the roof may fall down in one day.

Because of very dry air in the outside atmosphere the temperature of air coming out from the lower end of canals is on 12 degrees lower than the temperature of air far from the roof and might be used for cooling of the building inside. It is able to go inside without any fan, by the natural gravity only. See the Figure 1.

Such a combination of the roof, distiller and air cooler in one unit makes the device much cheaper than other facilities. We have calculated the possible market price for the water from the roof and found that it should be at least twice cheaper than the same quality water from the local market. It is about 50 cents per 10 liters.

The pumping of salt water to the roof is required energy. We were pumping the tap water from a tank to the altitude 6 meters by electric engine which has 200 Watts. On the remote places this power might be provided by solar panel or/and wind turbine.

Discussion

The distiller on the roof and the smoke tube condenser are very simple devices but would be very reliable and available for the population of the remote regions of Karakalpakstan. Even for towns they would be useful because there is a problem with high level of salty underground water table. This water is coming up and destroying foundations of buildings and soils inside of the cities and around of agricultural fields. Moreover the tap water quality is still low and a lot of people are buying bottled water. This bottled water is expensive for the rest of people so the new cheap technology will make the high quality drinking water available for the most population.

Almost all materials and parts are available in the local market and relatively cheap. Of course there should be governmental support to develop and implement the installations and such an aspiration is clearly indicated in the Program of the Government of Uzbekistan.

To optimize the processes of condensation and desalination is necessary to conduct a series of experiments, and we may reduce the cost of the water supply even more.

New materials are appears on the market, and for instance new metal-plastic combination coming closer to the ordinary tin-plate by cost.

Construction of the devices gave us good experience and we are ready to work out new modifications.